REMARKS

In view of the above amendments and following remarks, reconsideration of the rejections contained in the Office Action of January 25, 2006 is respectfully requested.

Proposed Claim Amendments

By the above amendments, applicants propose to cancel claims 25-26, 28-31, 33 and 40-42. Thus, by the entry of these amendments, the rejections of these claims by various of Rickerby et al., U.S. Patent No. 6,025,078, Nagaraj et al., U.S. Patent Publication 2005/0170200 (Nagaraj) and Subramanian, U.S. Patent Publication 2003/0211354 (Subramanian) would be rendered moot.

Further, claim 24 is proposed to be amended to include the limitations of claim 27, specifically, the ceramics layer having fine pores formed therein and a porosity of the pores, relative to the ceramics layer, being 8% or more and 15% or less. Claim 27 is thus also proposed to be cancelled.

Further, claim 24 is proposed to be amended to recite that the ytterbia is provided in an amount of 10 weight % or more and 25 weight % or less. Support for this amendment can for example be found at page 5 of the specification, lines 13-15. Claim 32 is thus proposed to be amended to recite that the weight % range is from 15 to 20.

These proposed amendments clearly place the present application into condition for allowance, and thus should be entered at this point in the prosecution. This will be explained in detail below.

The Present Invention

An object of the present invention is to enhance the thermal cycle durability, i.e. to increase resistance against peeling, of a thermal barrier coating (TBC). Peeling may happen over time in view of repeated starts and stops of, e.g., a gas turbine. Increasing the thermal cycle durability of the TBC would thus increase the number of times of turbine starts and stops as it would increase the number of starts and stops before peeling of the TBC begins.

In order to achieve the object above, the present inventors have introduced the concepts of porosity and cracks for mitigating thermal stress as a driving force behind

peeling of the TBC. Note for example tables 2 and 3. In particular, with regard to porosity, note that table 3 on page 32 of the specification indicates that with the addition of ytterbia as a stabilizer to the zirconia, the number of cycles of the resulting thermal life cycle is maximized (from 3528 cycles to 4528 cycles) in the porosity range of 8 to 15% of the ceramics layer. This is now proposed to be claimed in claim 24.

Further, to achieve the above object, in order to metallographically reduce the thermal stress as the driving force behind peeling of the TBC, the type of ceramic layer stabilizing agent is limited to ytterbia. Further, the amount of ytterbia is limited. Noting table 1, it can be seen that when the addition amount of ytterbia is 10 - 25 weight %, the thermal life cycle is maximized (from 526 to 4528 cycles). This is also proposed to be recited in claim 24. (The further preferred range of 15 to 20 weight % is proposed to be recited in claim 32.)

Accordingly, with the combination of conditions as now set forth in proposed claim 24, significant enhancement of the life cycle becomes possible. This is shown in tables 1-3, as well as Fig. 9.

The References Cited by the Examiner

Proposed claim 24 represents in effect prior claim 27, with the additional limitation directed to the weight % of ytterbia. The Examiner cited the combination of Rickerby, Nagaraj and Subramanian against this claim. However, none of these references, whether considered alone or in combination, properly suggests the invention as now set forth in claim 24.

Rickerby is directed to a metallic article having a thermal barrier coating. As stated at the beginning of the Summary of the Invention of Rickerby, the object is to provide a thermal barrier coating which has reduced thermal conductivity. As the Examiner acknowledges, Rickerby is silent with respect to both the presence of cracks and porosity. Thus, there is no goal of thermal stress mitigation by the use of cracks disclosed or suggested. In fact, it can be seen from column 8, lines 24-34, that the presence of voids is not necessarily something to be desired in Rickerby.

Rickerby provides a first metallic oxide to stabilize the zirconia, which can include ytterbia of 4-20%; the second metallic oxide, provided to reduce the thermal

conductivity, is present in an amount of 5-25%, and could also be ytterbia. A third metallic oxide could be provided as well to reduce photon thermal conductivity of the TBC.

Thus, it is clear that the focus of Rickerby is reduction of thermal conductivity. There is no stated concern with the thermal life cycle. There are no cracks. There is no discussion of a desired amount of porosity, furthermore.

Nagaraj is directed to a thermal barrier coating system suitable for use in applications requiring a thick TBC. As such, Nagaraj includes a fully stabilized outer layer forming microcracks for erosion resistance. This is provided on a partially stabilized inner layer characterized by low thermal conductivity. Ytterbia is mentioned as a possibility as the stabilizer, but is not the preferred stabilizer. Further, Nagaraj is silent as to the amount of ytterbia.

Nagaraj has the inner layer without vertical cracks, and the layer is tetragonal and cubic. The second layer is completely stabilized zirconia made of fluorite and has the vertical cracks. It is generally said that a completely stabilized area arises from ytterbia in an amount of 32 weight % or more. However, in a completely stabilized area, the thermal cycle durability is remarkably reduced. In the present specification, it is mentioned at page 15, line 2 that with an addition amount of ytterbia of 25% by weight or more, a tetragonal crystal arises, the t' phase lowers, and the durability deteriorates. The t' phase contributes to the thermal cycle, and so ytterbia is preferably 25% or less. In the completely stabilized area, however, there is no t' phase.

The Examiner cites Nagaraj as teaching cracks in the TBC of Rickerby. However, Nagaraj is teaching cracks in a fully stabilized area; accepting such a teaching from Nagaraj and applying it to Rickerby would result in the weight % of ytterbia, if ytterbia were the stabilizer, falling out of the claimed range. Rickerby does not teach cracks in the partially stabilized layer. Indeed, the partially stabilized area of Nagaraj, as with Rickerby, is provided for low thermal conductivity, and there are no cracks taught by Nagaraj for such an area. Thus it would not be obvious to combine Nagaraj with Rickerby in a manner so as to arrive at claim 24.

Nagaraj is silent with respect to the porosity. For this feature, however, the Examiner cites Subramanian.

Subramanian has the object of providing a material that is hardly sintered in order that the ceramics layer is provided with an abradable characteristic. Enhancement of the thermal cycle durability is not an object. In paragraph 20 on page 2 of Subramanian, it is discussed that the thermal barrier coating 10 may include voids 18 including generally spherical or other shape pores, generally horizontal cracks or defects, and generally vertical cracks or defects. Ytterbia is mentioned as a stabilizer, but the addition amount is at least 30 weight % (see paragraph 21). This amount of ytterbia is used to gain the range of porosity of 10 - 40 %, prefereably 10-20%, by the operation as discussed in paragraph 23 of Subramanian. That is, when the composition exceeds a certain value, as stated by Subramanian, vacancies wil form larger multi-vacancies. It is noted that this appears to be against the stated desire of Rickerby, as explained in column 8, lines 24-34 of Rickerby.

It should be noted that Subramanian is suggesting a higher range of porosity because cuttability or abradability is required. But there is no expressed concern with the thermal life cycle.

Thus, it must be emphasized that the present invention provides a combination of features that go toward the goal of improving the thermal life cycle of the TBC. The features include the cracks introduced into the ceramics layer, the ytterbia provided in the weight % amount of 10 - 25, and the porosity provided in a range of 8 - 15 %. The combination of features results in the significantly improved life cycle, as discussed above and as is clear from tables 1-3 of the specification. While the prior art provides distinct instances of the presence of some features and overlapping ranges in separate patents, there is no proper motivation to combine them to arrive at the present invention of claim 24. None of the cited references address goal of the invention, and thus there is no motivation to combine the lower range of weight % of ytterbia with the particular porosity range. And as explained above, there are reasons why one of ordinary skill in the art would not have made such combination, as the combination of the claimed

porosity range and weight % range are against the teachings of one or the other of the references.

Accordingly, it is respectfully submitted that claim 24 proposes subject matter that clearly distinguishes over the art of record. As such, entry of the above amendment at this point in the prosecution is in order, and such entry is requested. Indication of the allowability of all of the claims is further requested.

In view of the above amendments and remarks, it is submitted that the present application is now in condition for allowance, and the Examiner is requested to pass the case to issue. If the Examiner should have any comments or suggestions to help speed the prosecution of this application, the Examiner is requested to contact Applicants' undersigned representative.

Respectfully submitted,

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